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Issued May 3, 1910.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—BULLETIN No. 64.

MILTON WHITNEY, Chief.

FERTILIZERS FOR CORN SOILS.

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MILTON WHITNEY.

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1862 1889

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., September 1, 1909.

Sir: In order to establish certain fundamental principles regarding the effect and efficiency of fertilizers on corn soils, I have had compiled all the available results of plat tests which have been carried out by the experiment stations.

It is believed that this matter will be of considerable interest to the farmers of the country, and I therefore have the honor to recommend that the material be published as Bulletin No. 64 of the Bureau of Soils.

Very respectfully,

Milton Whitney,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FERTILIZERS FOR CORN SOILS.

INTRODUCTION.

The agricultural experiment stations have recorded in their reports and bulletins the results of 6,394 tests of substances applied as fertilizers to corn soils, which results have been summarized in the following pages.

Each test represents some single substance used alone or some combination of substances and every result where the yield of a "check" or unfertilized plat has been recorded has been taken, when the amount of each substance per acre could be determined, and when the yield or increased yield of corn per acre could be found. The results have been accepted whether the plats were located on the station farm or the experiments were carried out by cooperating farmers. No experiments from any source, not accepted and adopted by the stations and rendered in their official publications, are considered in this bulletin.

When the results are given in pounds of corn on the cob they have been reduced to bushels of shelled corn by dividing by 70. When given in pounds of shelled corn they have been reduced to bushels by dividing by 56. When materials applied to the soil have been given in measures of volume they have been reduced to pounds by the most reliable figures obtainable. For example a bushel of stone lime has been assumed to weigh 80 pounds; a bushel of agricultural lime, 45 pounds; a one-horse load of manure has been taken to weigh 600 pounds, while a two-horse load has been assumed to weigh 2,000 pounds. The value assigned to shelled corn is 60 cents per bushel, which is approximately the farm value for 1908, as given in the appendix of the Yearbook of this Department for 1908, page 598.

NUMBER OF EXPERIMENTS.

The number of individual fertilizer tests which have been obtained from the experiment station literature of each State is given in the table following.

Fertilizer plat tests on corn soils, arranged according to the number of individual tests made in each State from 1869 to 1907, inclusive.

State.	Number of tests.	State.	Number of tests.
Pennsylvania	924	Michigan	92
Ohio	917	Delaware	83
Connecticut	628	West Virginia	80
Rhode Island	512	New York	72
Louisiana	471	Alabama	63
Georgia	314	Massachusetts	59
Maryland	285	Texas	48
North Carolina	265	Virginia	44
Mississippi	201	Kansas	21
South Carolina	188	Arkansas	20
Indiana	183	Minnesota	18
Tennessee	177	Missouri	16
New Jersey	171	Wisconsin	10
Illinois	160	Colorado	4
Kentucky	142		
New Hampshire	127	Total	6,394
Maine	99		

Of the 31 States reporting results of fertilizer tests on corn soils, 9 have over 200 results each, namely, Pennsylvania, Ohio, Connecticut, Rhode Island, Louisiana, Georgia, Maryland, North Carolina, and Mississippi, and 7 have from 100 to 200, namely, South Carolina, Indiana, Tennessee, New Jersey, Illinois, Kentucky, and New Hampshire. The remaining 15 States each have less than 100 tests. The 16 Northern States in the list are credited with 3,997 tests, and the 15 Southern States with 2,397 tests, which gives a very fair distribution of the results under the climatic conditions in the eastern half of the United States.

It is not always possible to determine from the records the year in which the recorded experiment was actually carried on, but the following table gives, as accurately as can be, the distribution of work by years:

The number of individual tests on corn soil for 1869, 1870, and 1872, and for each year from 1880 to 1907, inclusive.

Year.	Number.	Year.	Number.	Year.	Number.	Year.	Number.
1869	31	1886	305	1894	241	1902	205
1870	55	1887	91	1895	175	1903	137
1872	10	1888	514	1896	290	1904	58
1880	16	1889	906	1897	159	1905	71
1881	55	1890	630	1898	134	1906	53
1882	143	1891	536	1899	167	1907	65
1883	114	1892	402	1900	70		
1884	182	1893	392	1901	53	Total	6,394
1885	134						

It will be seen that, judging from the number of results recorded, the greatest activity in this line of experimentation was in the year 1889 and in the period from 1886 to 1894, and that since 1899, with the exceptions of the years 1902 and 1903, there has been a decided falling off in such work.

One notable series of experiments reported upon has been running continuously for fourteen years. In the great majority of cases, however, the tests have been for single years, or at most, for three or four years.

The tests have been made on soils of all degrees of productivity, from those producing on the unfertilized "check" at the rate of less than 1 bushel to those producing over 90 bushels of shelled corn per acre. It is impossible from the records to determine the types of soils upon which the experiments have been made, as the descriptions of the physical and chemical properties of the soil, in few cases adequate, are in the majority of cases entirely omitted.

The recorded yield on the duplicate "check" or unfertilized plats varies widely in many cases, as will be seen from the table following.

Yield of corn, in bushels per acre, on unfertilized plats when more than one such plat is given.

Yield.	Yield.	Yield.	Yield.	Yield.	Yield.	Yield.	Yield.	Yield.
Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
4.2 4.4 **4.3**	6.5 11.9 **9.2**	12.1 15.2 **13.7**	10.0 13.1 17.1 32.0 **18.0**	16.0 19.1 21.3 21.7 22.7 **20.2**	22.5 22.6 24.0 24.8 25.1 25.4 28.3 31.8 36.8 **22.6**	22.4 32.0 **27.2**	28.5 28.7 28.8 34.2 35.0 **28.3**	20.0 25.7 25.8 30.2 35.8 39.0 39.9 **30.9**
3.6 3.8 5.0 5.8 **4.6**	9.2 10.1 10.3 **9.9**	11.7 15.8 **13.8**	13.3 17.7 18.6 23.1 **18.2**	15.7 26.0 **20.8**	14.3 20.0 24.2 26.9 27.4 **22.6**	22.6 26.6 28.0 28.3 31.4 **27.4**	28.4 29.3 **28.8**	21.0 41.0 **31.0**
4.2 5.2 **4.7**	6.5 9.6 12.0 13.7 **10.4**	13.3 15.0 **14.1**	5.2 13.6 16.7 23.6 26.3 28.0 **18.9**	16.1 21.1 25.1 **20.8**	20.9 21.3 23.4 23.6 24.3 **22.7**	21.3 23.3 24.6 24.8 26.4 26.8 27.0 28.2 28.3 44.8 **27.6**	21.3 29.1 29.3 30.7 34.1 **28.9**	29.1 33.1 **31.1**
3.5 6.1 **4.8**	8.8 13.6 **11.2**	12.7 13.5 14.7 15.1 16.4 **14.5**	14.8 16.2 17.2 17.3 17.3 17.7 18.0 21.1 21.2 22.2 25.3 **18.9**	17.3 24.5 **20.9**	21.0 23.4 26.8 **23.7**	27.6 27.6 **27.6**	26.7 32.0 **29.4**	26.3 36.0 **31.2**
4.9 5.0 **4.9**	10.0 11.4 12.9 **11.4**	10.3 19.3 **14.8**	14.0 23.9 **19.0**	16.8 21.1 25.1 **21.0**	20.6 22.9 22.9 25.7 27.4 **23.9**	19.7 36.0 **27.8**	28.6 29.0 30.9 **29.5**	29.0 31.3 31.6 31.8 35.7 **31.9**
3.9 7.3 **5.6**	9.9 11.4 13.8 **11.7**	14.3 14.9 15.8 **15.0**	12.6 15.1 17.7 23.8 28.2 **19.5**	19.7 22.3 **21.0**	21.2 23.4 28.5 **24.4**	9.7 21.1 30.3 37.7 40.0 **27.8**	17.1 17.1 29.7 36.8 46.9 **29.5**	22.7 27.4 29.6 31.1 33.9 35.9 43.3 **32.0**
2.8 8.6 **5.7**	10.0 10.0 13.1 14.2 **11.8**	12.9 14.9 17.7 **15.2**	17.8 21.4 **19.6**	16.2 26.8 **21.5**	12.3 23.1 27.4 29.5 30.7 **24.6**	26.7 28.5 26.7 **27.3**	29.0 29.0 31.0 **29.7**	28.1 28.1 28.9 43.7 **32.2**
3.4 4.3 6.3 8.8 **5.7**	11.2 13.0 **12.1**	13.0 14.9 17.7 **15.2**	3.6 12.2 17.2 20.5 25.8 28.0 31.7 **19.9**	21.1 21.9 **21.5**	18.3 23.3 25.9 27.7 29.4 **24.9**	18.1 19.4 19.4 34.3 49.4 **28.1**	27.4 29.9 30.4 31.1 32.2 **30.2**	21.3 31.5 33.0 34.7 41.0 **32.3**
5.7 7.0 **6.3**	9.9 14.7 **12.3**	14.8 16.8 **15.8**	12.5 14.3 14.7 15.6 17.5 18.6 19.6 19.8 21.2 23.1 24.5 24.7 25.8 26.5 **19.9**	13.1 30.3 **21.7**	19.0 32.0 **25.5**	24.9 25.9 28.4 28.9 33.1 **28.2**	29.9 30.9 **30.4**	27.1 37.6 **32.3**
6.4 6.4 **6.4**	9.4 15.6 **12.5**	8.9 23.1 **16.0**		19.5 19.8 27.1 **22.1**	15.4 18.8 23.5 23.7 24.5 25.3 27.9 31.5 32.3 35.4 **25.8**	18.3 23.4 25.7 30.9 42.9 **28.2**	26.8 34.2 **30.5**	30.2 34.4 **32.3**
6.3 6.5 6.9 **6.6**	7.2 11.8 18.5 **12.5**	12.3 20.0 **16.1**		14.4 16.3 16.8 24.6 24.7 25.7 26.2 28.1 **22.1**		23.2 24.0 25.5 26.6 28.3	19.5 19.5 29.0 29.1 29.2 29.7 30.3 30.8 32.2 32.2 34.0 34.3 39.3 41.9 **30.8**	31.6 34.7 **33.1**
5.7 6.8 7.9 8.1 9.4 **7.6**	12.0 14.1 **13.1**	12.7 21.2 **17.0**		20.4 21.8 22.8 23.5 23.6 **22.4**				28.0 33.6 38.9 **33.5**
4.3 5.3 9.7 13.7 **8.2**	11.7 13.1 16.0 **13.6**	7.6 10.2 13.2 14.6 14.7 16.0 16.7 17.3 17.4 17.5 17.7 19.3 27.9 28.2 **17.0**		11.4 12.9 16.1 16.5 17.9				
7.6 10.5 **9.1**	12.3 14.8 **13.6**							

Yield of corn, in bushels per acre, on unfertilized plats when more than one such plat is given—Continued.

Yield.	Yield.	Yield.	Yield.	Yield.	Yield.	Yield.	Yield.	Yield.
Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
33.1 36.2 **34.6** 31.1 32.1 32.2 32.9 33.2 36.9 40.5 40.6 **34.9** 31.9 38.0 **35.0** 32.0 38.3 **35.2** 30.0 37.0 39.0 **35.3** 34.3 38.0 **36.2** 18.9 26.1 28.8 48.0 61.3 **36.6** 30.2 34.0 46.0 **36.7** 23.5 33.5 39.0	42.5 45.5 **36.8** 29.2 29.8 30.8 33.8 39.8 41.6 47.1 47.7 **37.5** 26.4 36.4 37.1 42.9 47.6 **38.1** 29.4 32.5 33.2 36.3 36.4 37.2 38.1 39.3 41.1 44.6 45.1 46.4 **38.3** 35.6 37.0 37.0 38.2 38.3 38.7 41.7 42.4 **38.6** 37.3 40.0 **38.7**	38.2 42.8 **40.5** 31.8 40.0 40.9 43.7 44.0 45.8 **41.0** 34.3 36.4 37.0 40.1 42.9 43.9 45.3 45.7 46.4 49.1 **42.1** 40.9 42.4 42.6 42.6 42.6 **42.2** 41.3 44.2 **42.7** 34.2 38.6 40.2 41.7 44.6 47.1 47.1 48.6 **42.8** 26.9 29.9	48.0 54.4 56.8 **43.2** 41.6 45.4 **43.5** 42.6 45.8 **44.2** 39.0 42.0 50.0 **44.0** 30.2 44.6 46.1 50.1 51.8 **44.6** 39.8 49.7 **44.8** 41.4 46.0 48.0 **45.1** 39.9 43.6 44.1 47.0 47.7 48.1 51.3 51.6 **46.6**	44.4 49.3 **46.8** 42.7 43.7 44.9 45.6 47.0 48.5 49.4 52.3 **46.8** 38.9 42.3 43.4 49.1 62.9 **47.3** 43.5 54.0 **48.7** 37.9 38.1 49.5 50.2 50.2 52.0 59.5 61.6 **49.9** 41.1 47.4 49.1 50.3 65.1 **50.6** 46.9 55.5 **51.2**	44.8 47.6 49.7 50.2 51.0 53.7 53.9 53.9 55.6 59.6 **52.0** 40.1 48.3 56.5 58.7 64.0 **53.5** 51.0 58.0 **54.5** 49.8 59.3 **54.6** 46.9 50.3 57.1 57.2 61.7 **54.6** 40.2 70.2 **55.2** 52.7 53.3 54.5 56.3 60.7 **55.5** 55.0	57.0 **56.0** 52.0 53.5 57.5 58.0 59.0 **56.0** 52.6 59.5 **56.0** 45.0 55.0 60.0 60.0 60.0 **56.0** 50.4 52.3 56.4 58.2 58.3 59.4 59.7 65.4 **57.5** 56.0 61.0 **58.5** 34.7 55.2 59.2 68.3 73.9 **58.3** 53.5 57.8 58.1 62.2	65.7 **59.5** 53.5 57.8 58.1 62.2 65.7 **59.5** 44.8 60.0 60.3 67.1 67.4 **59.9** 56.3 66.6 **61.4** 55.4 56.7 59.3 61.1 61.3 64.6 67.7 68.8 **61.9** 58.5 64.3 67.3 **63.4** 63.9 64.5 **64.2** 61.4 63.3 64.7 64.9 66.0 66.3	68.3 68.6 **65.4** 65.6 66.4 **66.0** 62.4 72.1 **67.2** 62.0 68.0 72.0 **67.3** 66.6 69.3 **67.9** 51.8 60.3 86.0 86.4 94.5 **75.8** 75.0 83.0 **79.0** 78.6 86.0 87.4 90.5 92.1 93.0 94.2 100.0 **90.2**

With duplicates varying as widely as indicated by the above table, no strict or exact quantitative comparisons can be made of observed differences due to fertilizer treatment. This fact must be borne in mind in interpreting or applying the data given in the following tables, and decidedly less weight should be given results from a few experiments than from the averages of a great many.

The subject of variation in duplicate plats, and the possible errors arising from lack of uniformity in such work as this, has been studied at one of the experiment stations, with the following results:[a]

There is scarcely anyone interested in agricultural experiments who will not admit that the ultimate test of many theories must be found in field experimentation. While this is acknowledged, all who have conducted or watched field experiments by the plat method are aware that there is great difficulty in avoiding error, and that this is largely due to unavoidable differences in the yield of small plats, because of natural variations in the fertility of different parts of the same field. Some have gone so far as to assert that this difficulty can not be overcome to a sufficient extent to admit of the use of the results of field experiments as a basis for reliable conclusions. Others believe that with proper precautions such experiments can be made to determine to quite a close approximation the comparative effect of different fertilizers, different methods of tillage, etc. It is certainly true that if a single plat is compared with some other plat in the series the natural difference in production is sometimes as great as would be expected if one plat had been manured and the other had not. Even contiguous plats occasionally yield quite different results under the same treatment.

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[a] Rept. Pennsylvania State College, 1882–1886, p. 295.

Notwithstanding these facts, it is the opinion of the writer after conducting considerable (sic.) many field experiments and noting the results from a great many others, that it is possible to reduce the error of field experiments to such a small amount that it will not materially vitiate the reliability of the conclusions that may be drawn.

One of the experiments on the Central experimental farm during the summer of 1883 was the testing of the uniformity of production of 36 plats of land which are now being used for various experiments. These plats are contained in two series or tiers running parallel to each other. Each plat is 1 rod wide and 8 rods long, containing one-twentieth of an acre, and is separated from the contiguous plats by a strip of land 2 feet wide. No fertilizer was applied to any of these plats, and they were treated exactly alike as to manner and time of cultivation and quantity of seed. The table * * * gives the yield of the individual plats in each series, the average yield for all the plats of each series, the variation of each plat from the average yield, and the average variation.

Table showing the comparative yield of small plats of land when treated alike.

First series.					Second series.				
Yield of oats per acre.			Variation from the average yield of all the plats in the series.		Yield of oats per acre.			Variation from the average yield of all the plats in the series.	
	Grain.	Straw.	Grain.	Straw.		Grain.	Straw.	Grain.	Straw.
	Bushels.	*Pounds.*	*Bushels.*	*Pounds.*		*Bushels.*	*Pounds.*	*Bushels.*	*Pounds.*
A........	43.8	2,900	−8.1	+224	A1.......	56.2	2,600	+9.4	+116
B........	43.1	2,920	−8.8	+244	B1.......	45.6	2,740	−1.2	+256
C........	52.5	2,720	+ .6	+ 44	C1.......	47.5	2,380	+ .7	−104
D........	48.4	2,760	−3.5	+ 84	D1.......	44.4	2,480	−2.4	− 4
E........	50.6	2,880	−1.3	+204	E1.......	47.5	2,380	+ .7	−104
F........	49.4	2,620	−2.5	− 56	F1.......	50.6	2,180	+3.8	−304
G........	48.4	2,460	−3.5	−216	G1.......	39.0	2,360	−7.8	−124
H........	50.0	2,700	−1.9	+ 24	H1.......	47.5	2,580	− .7	+ 96
I........	52.5	2,420	+ .6	−256	I1.......	43.7	2,400	−3.1	− 84
J........	50.0	2,900	−1.9	+224	J1.......	38.1	2,480	−8.7	− 4
K........	57.5	3,160	+5.6	+484	K1.......	47.5	2,780	+ .7	+296
L........	56.2	2,900	+4.3	+224	L1.......	47.5	2,380	+ .7	−104
M........	55.0	2,740	+3.1	64	M1.......	50.6	2,480	+3.8	− 4
N........	55.0	2,740	+3.1	64	N1.......	43.7	2,500	−3.1	+ 16
O........	56.2	2,300	+4.3	−376	O1.......	44.4	2,380	−2.4	−104
P........	55.6	2,420	+3.7	−256	P1.......	50.6	2,380	+3.8	−104
Q........	56.9	2,680	+5.0	4	Q1.......	49.0	2,440	+2.2	− 44
R........	53.7	1,950	+1.8	−726	R1.......	50.0	2,800	+3.2	+316
Average..	51.9	2,676	3.6	209	....	46.8	2,484	3.2	122

A closer examination of the first table shows, however, that the cases of large variation from the average yield are quite few. No one of 29 plats out of the 36 varies in production of grain more than 8.2 per cent from the average. With 23 plats the variation from the average yield of grain was less than the mean variation.

Nevertheless, it is quite evident that, although these plats were laid out on land of more than average uniformity in quality, the comparison of the yields of single plats for a single year, in order to determine the effect of different fertilizers or different methods of treatment, might be very misleading.

KINDS AND COST OF THE FERTILIZERS USED.

In the 6,394 tests on corn soils which are reported upon in this bulletin there have been used 45 substances and 173 combinations of substances, without considering the different proportions of the several ingredients in the combinations. In computing the relative efficiency, from a commercial standpoint, of the several substances, there must be assigned to each some arbitrary value which will represent, as fairly as possible, the average cost to the farmer in the several States. However, when these values for any reason do not represent local market conditions, the data contained in the subsequent tables are sufficient to enable a recalculation to be made on any new basis of value.

The values used in computing the commercial efficiency of fertilizers in this bulletin are given in the following table:

Valuation of fertilizers used in plat tests on corn soils.

Ingredient.	Cost per ton.	Ingredient.	Cost per ton.
	Dollars.		*Dollars.*
Nitrate of soda	50.00	Magnesium oxide	(a)
Sulphate of ammonia	62.00	Magnesium sulphate	(a)
Ammonium phosphate	(a)	Krugit	(a)
Acid phosphate	14.00	Barium oxide	(a)
Rock phosphate	9.00	Sylvanite	(a)
Floats	8.00	Sulphate of iron	(a)
Basic slag	12.50	Lime	6.00
Bone ash	50.00	Marl	.50
Iron-alumina phosphate	(a)	Gypsum	8.00
Sulphate of potash	60.00	Soft-coal ashes	(a)
Muriate of potash	44.00	Salt	8.00
Kainit	12.00	Soil	(a)
Sand	(a)	Corn meal	(a)
Oyster shells	(a)	Wheat bran	(a)
Dried blood	40.00	Straw	(a)
Tankage	26.00	Tobacco stems	15.00
Fish scrap	40.00	Muck	(a)
Linseed meal	38.00	Charcoal	(a)
Boneblack	22.00	Seaweed	(a)
Ground bone	26.00	Guano	50.00
Cotton seed	16.00	Azotine	(a)
Cotton-seed meal	25.00	Ammonite	(a)
Cotton-seed hulls	4.50	Peat	(a)
Castor pomace	23.00	Manure	.50
Nitrate of potash	50.00	Cow manure	.50
Cotton-seed-hull ashes	34.00	Hog manure	.50
Cob ash	(a)	Hen manure	15.00
Wood ashes	5.00	Compost	.50
Potash-magnesium sulphate	(a)	Commercial fertilizer	20.00

[a] Not valued.

TABULATION OF RESULTS.

The following table gives a complete summary of the results of the fertilizer tests on corn soils. The figures in the first column indicate the number of experiments which have been reported, with each substance tried. The actual experiment was usually performed on one-twentieth or one-tenth acre plats, but the results are uniformly stated in pounds per acre, both in case of fertilizers applied and in crop returns, and this unit is retained throughout this bulletin. The second column of figures shows the relative number of increases to no increases reported from the use of the several fertilizers. With nitrate of soda, for example, the chances based upon the 249 trials which have been reported are 2.5 to 1 that there will be an increase of corn attending its use alone.

The third column of figures shows the extreme range of effectiveness of the several fertilizers within the limit of the observations which have been made. With nitrate of soda there has been at least one case where the yield was 20.6 bushels less per acre than the unfertilized plat and at least one case where the yield was 28 bushels more. The sixth column gives the average increase or decrease, in bushels per acre, attributable to the fertilizers used. This information, together with the average amount of fertilizer used per acre, its cost, and the value of the increased product of corn, gives the basis for calculating the average gain or loss in money value. This is accurate, except that in no case has any allowance been made for the cost of applying the fertilizers to the land.

Results of fertilizer tests with corn soils.

MINERALS SINGLY.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Nitrate of potash	1	1.0:0	4.8	280	7.20	4.8	2.88	−4.32
Nitrate of soda	249	2.3:1	−20.3 to 28.0	214	5.34	3.8	2.28	−3.06
Sulphate of ammonia	52	1.0:1	−16.6 to 43.0	240	7.46	0.9	0.54	−6.92
Ammonium phosphate	2	1.9:0	4.6 to 13.8	200	....	[a] 9.2	[a] 5.52	....
Acid phosphate	405	1.5:1	−26.6 to 46.9	368	2.57	3.4	2.04	0.53
Rock phosphate	54	1.6:1	−26.0 to 20.2	692	3.12	1.7	1.02	−2.10
Floats	11	4.5:1	− 1.0 to 33.4	291	1.16	8.2	4.92	3.76
Basic slag	23	1.6:1	−28.1 to 14.2	762	4.77	−0.5	−0.30	−5.07
Iron-alumina phosphate	6	5.0:1	−17.3 to 12.3	370	....	[a] 2.5	[a] 1.50	....
Sulphate of potash	23	1.1:1	−21.2 to 46.0	198	5.94	6.3	3.78	−2.16
Muriate of potash	289	2.2:1	−19.0 to 82.4	171	3.75	6.3	3.78	0.03
Kainit	84	2.0:1	− 8.1 to 40.4	381	2.28	4.9	2.94	0.66
Cotton-seed-hull ashes	16	1.7:1	− 4.2 to 44.5	277	4.70	5.3	3.18	1.52
Cob ash	1	1.0:0	0.6	250	....	[a] 0.6	[a] 0.36	....
Wood ashes	27	2.4:1	−49.2 to 60.0	928	2.30	7.8	4.68	2.38
Magnesium oxide	4	4.0:0	3.2 to 42.8	1,400	....	[a] 17.1	[a] 10.26	....
Magnesium sulphate	1	1.0:0	57.3	970	....	[a] 57.3	[a] 34.38	....
Krugit	1	1.0:0	56.2	800	....	[a] 56.2	[a] 33.72	....
Barium oxide	4	4.0:0	1.2 to 9.1	1,400	....	[a] 5.7	[a] 3.42	....
Sulphate of iron	4	0.3:1	−15.1 to 2.3	55	....	[a] −5.0	[a] −3.00	....
Lime	168	1.6:1	−38.4 to 50.9	2,972	8.91	3.2	1.92	−6.99
Marl	9	3.5:1	− 3.5 to 47.5	8,600	2.15	11.1	6.66	4.51
Gypsum	173	1.3:1	−38.3 to 21.0	419	1.68	0.6	0.36	−1.35
Soft-coal ashes	4	1.0:1	− 3.7 to 3.1	13,000	....	[a] −0.4	[a] 0.24	....
Salt	11	1.7:1	− 7.1 to 14.3	450	1.80	1.6	0.96	−0.84
Total	1,622	1.9:1	....	....	4.03	3.7	2.22	−1.81

[a] Omitted from average yield.

Results of fertilizer tests with corn soils—Continued.

MIXTURES OF TWO MINERALS.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Nitrate of soda Sulphate of ammonia	4	4.0:0	7.5 to 8.9	50 50	2.80	8.2	4.92	2.12
Nitrate of soda Acid phosphate	196	8.9:1	− 8.5 to 38.2	175 325	6.64	10.4	6.24	− 0.40
Nitrate of soda Rock phosphate	3	3:0	0.1 to 12.8	227 187	6.51	4.6	2.76	− 3.75
Nitrate of soda Floats	1	1:0	4.5	128 200	4.00	4.5	2.70	− 1.30
Nitrate of soda Basic slag	1	1:0	4.2	80 140	2.87	4.2	2.52	− 0.35
Nitrate of soda Sulphate of potash	1	1:0	48.0	160 160	8.80	48.0	28.80	20.00
Nitrate of soda Muriate of potash	194	8.2:1	−15.2 to 84.0	178 139	7.52	11.9	7.14	− 0.38
Nitrate of soda Kainit	10	9.0:1	− 2.3 to 27.3	149 198	4.90	6.5	3.90	− 1.00
Nitrate of soda Lime	1	0:1	− 6.4	100 600	4.30	− 6.4	− 3.84	− 8.14
Sulphate of ammonia Acid phosphate	20	1.9:1	−35.8 to 49.4	119 252	5.45	7.6	4.56	− 0.89
Sulphate of ammonia Rock phosphate	2	2.0:0	1.5 to 7.5	200 200	7.10	4.5	2.70	− 4.40
Sulphate of ammonia Sulphate of potash	2	2.0:0	19.1 to 22.5	150 150	9.15	20.8	12.48	3.33
Sulphate of ammonia Muriate of potash	18	2.6:1	−14.2 to 65.7	120 211	8.36	16.2	9.72	1.36
Acid phosphate Sulphate of potash	8	0.6:1	−13.4 to 40.0	434 162	8.12	5.6	3.36	− 4.76
Acid phosphate Muriate of potash	455	6.6:1	−14.0 to 112.0	332 152	5.66	12.1	7.29	1.63
Acid phosphate Kainit	82	2.6:1	−13.1 to 27.8	207 142	2.30	3.2	1.92	− 0.38
Acid phosphate Cotton-seed-hull ashes	4	4.0:0	0.1 to 5.0	200 180	4.46	1.8	1.08	− 3.38
Acid phosphate Lime	8	3.0:1	− 2.4 to 14.7	450 1,300	7.05	6.9	4.14	− 2.91
Rock phosphate Muriate of potash	2	2.0:0	7.2 to 14.2	200 300	7.50	10.7	6.42	− 1.08
Rock phosphate Kainit	3	3.0:0	1.6 to 9.6	184 157	1.77	5.3	3.18	1.41
Floats Kainit	2	2.0:0	1.1 to 11.4	200 200	2.00	6.2	3.72	1.72
Floats Wood ashes	1	1.0:0	31.1	200 200	1.30	31.1	18.66	17.36
Sulphate of potash Lime	1	0:1	− 4.0	120 600	5.40	− 4.0	− 2.40	− 7.80
Muriate of potash Lime	6	2.0:1	−45.6 to 114.8	200 2,000	10.40	29.5	17.70	7.20
Kainit Lime	2	2.0:0	19.6 to 31.9	2,000 10,000	42.00	25.7	15.42	−26.58
Muriate of potash Soil	1	1.0:0	23.0	160 160	3.52	23.0	13.80	10.28
Kainit Sand	2	2.0:0	19.4 to 22.9	200 8,000	1.20	21.1	12.66	11.46
Muriate of potash Wood ashes	1	0:1	− 2.3	200 500	5.65	− 2.3	− 1.38	− 7.03
Wood ashes Sand	2	2.0:0	20.6 to 30.0	368 8,000	0.83	25.3	15.18	14.35
Gypsum Wood ashes	3	2.0:1	− 0.1 to 18.2	200 347	1.67	9.2	5.52	3.85
Total	1,036	5.9:1			6.03	11.0	6.60	0.57

Results of fertilizer tests with corn soils—Continued.

MIXTURES OF THREE OR MORE MINERALS.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Nitrate of soda Sulphate of ammonia Acid phosphate	2	1.0:1	− 3.4 to 25.8	165 158 375	11.65	11.2	6.72	− 4.93
Nitrate of soda Sulphate of ammonia Muriate of potash	1	1.0:0	6.6	160 120 80	9.48	6.6	3.96	− 5.52
Nitrate of soda Acid phosphate Sulphate of potash	10	9.0:1	0.93 to 46.0	209 147 95	9.48	13.1	7.86	− 1.26
Nitrate of soda Acid phosphate Muriate of potash	677	20.8:1	− 8.4 to 84.2	239 277 124	10.64	13.1	7.86	− 2.78
Nitrate of soda Acid phosphate Kainit	36	36.0:0	3.6 to 31.3	310 269 210	10.88	14.9	8.94	− 1.94
Nitrate of soda Acid phosphate Potash-magnesium sulphate.	1	1.0:0	16.6	290 500 485	10.75	16.6	9.96	− 0.79
Nitrate of soda Acid phosphate Soil	1	1.0:0	2.0	160 320 160	6.24	2.0	1.20	− 5.04
Nitrate of soda Rock phosphate Muriate of potash	14	2.5:1	− 4.5 to 68.0	181 374 104	8.49	12.0	7.20	− 1.29
Nitrate of soda Floats Muriate of potash	6	6.0:0	1.9 to 6.4	247 49 100	8.56	3.4	2.04	− 6.52
Nitrate of soda Basic slag Muriate of potash	32	3.5:1	− 3.9 to 85.0	199 204 108	8.61	7.9	4.70	− 3.91
Nitrate of soda Muriate of potash Soil	1	1.0:0	31.0	160 160 160	7.52	31.0	18.60	11.08
Sulphate of ammonia Acid phosphate Sulphate of potash	2	2.0:0	25.1 to 39.4	150 300 130	10.65	32.2	19.32	8.67
Sulphate of ammonia Acid phosphate Kainit	7	7.0:0	1.9 to 17.5	166 129 75	6.50	10.0	6.00	− 0.50
Sulphate of ammonia Acid phosphate Muriate of potash	389	7.5:1	−43.7 to 126.0	189 322 141	11.20	17.5	10.50	− 0.70
Sulphate of ammonia Acid phosphate Potash-magnesium sulphate.	1	1.0:0	3.9	225 500 485	10.45	3.9	2.34	− 8.11
Sulphate of ammonia Bone ash Muriate of potash	1	1.0:0	5.3	120 160 100	9.92	5.3	3.18	− 6.74
Sulphate of ammonia Rock phosphate Muriate of potash	8	8.0:0	2.7 to 43.5	158 571 163	12.03	19.4	11.64	− 0.61
Sulphate of ammonia Sulphate of potash Muriate of potash	1	0:1	− 0.3	160 160 160	13.28	− 0.3	− 0.18	−13.46
Acid phosphate Sulphate of potash Muriate of potash	1	1.0:0	13.0	370 73 73	6.39	13.0	7.80	1.41
Acid phosphate Muriate of potash Kainit	1	1.0:0	10.1	400 150 100	6.70	10.1	6.06	− 0.64
Acid phosphate Sulphate of potash Lime	1	0:1	−14.0	320 120 600	7.64	−14.0	− 8.40	−16.04

Results of fertilizer tests with corn soils—Continued.

MIXTURES OF THREE OR MORE MINERALS—Continued.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Acid phosphate Muriate of potash Lime	9	9.0:0	2.0 to 11.5	600 200 1,667	13.60	7.4	4.44	— 8.16
Rock phosphate Muriate of potash Lime	1	1.0:0	21.0	1,000 100 200	7.30	21.0	12.60	5.30
Acid phosphate Muriate of potash Soil	1	1.0:0	28.0	320 160 160	9.20	28.0	16.80	7.60
Lime Wood ashes Salt	1	1.0:0	6.1	1,500 1,500 1,500	14.25	6.1	3.66	—10.59
Nitrate of soda Sulphate of ammonia Acid phosphate Sulphate of potash	1	1.0:0	0.8	240 100 200 200	16.50	0.8	0.48	—16.02
Nitrate of soda Sulphate of ammonia Rock phosphate Muriate of potash	5	5.0:0	14.5 to 24.5	225 150 150 225	15.89	20.9	12.54	— 3.35
Nitrate of soda Acid phosphate Muriate of potash Lime	12	11.0:1	— 1.9 to 40.1	260 510 170 1,765	19.11	20.8	12.48	— 6.63
Nitrate of soda Rock phosphate Muriate of potash Lime	1	1.0:0	83.0	150 1,000 100 200	11.05	83.0	49.80	38.75
Sulphate of ammonia Acid phosphate Sulphate of potash Sulphate of iron	1	0:1	— 8.0	150 300 100 60	9.75	— 8.0	— 4.80	—14.55
Sulphate of ammonia Acid phosphate Muriate of potash Lime	8	8.0:0	1.8 to 20.4	225 600 200 1,667	20.58	11.0	6.60	—13.98
Total	1,233	12.1:1	....	....	10.89	14.5	8.70	— 2.19
ORGANIC FERTILIZERS SINGLY.								
Dried blood	45	1.4:1	—14.2 to 20.9	204	4.07	2.0	1.20	— 2.87
Tankage	18	0.4:1	— 5.0 to 3.2	286	3.72	— 1.2	— 0.72	— 4.44
Fish scrap	5	5.0:0	8.0 to 18.9	337	6.73	13.4	8.04	1.31
Linseed meal	10	4.0:1	— 3.5 to 15.0	1,158	22.00	6.1	3.66	—18.34
Boneblack	11	0.8:1	—17.1 to 11.8	472	5.19	— 1.4	— 0.84	— 6.03
Ground bone	70	1.8:1	—25.5 to 24.9	404	5.25	3.0	1.80	— 3.45
Cotton seed	36	11.0:1	— 6.8 to 12.4	800	6.40	4.4	2.64	— 3.76
Cotton-seed meal	83	6.0:1	— 8.6 to 18.2	344	4.30	6.0	3.60	— 0.70
Caster pomace	8	1.7:1	—10.9 to 20.0	303	3.80	4.6	2.76	— 1.04
Corn meal	1	1.0:0	0.5	250	....	[a] 0.5	[a] 0.30	....
Wheat bran	1	1.0:0	10.0	400	....	[a] 10.0	[a] 6.00	....
Straw	2	2.0:1	13.9 to 30.8	....	....	[a] 22.3	[a] 13.38	....
Tobacco stems	9	8.0:1	— 1.4 to 50.5	742	5.57	28.5	17.10	11.53
Muck	1	1.0:0	1.4	12,000	....	[a] 1.4	[a] 0.84	....
Charcoal	1	1.0:0	6.4	200	....	[a] 6.4	[a] 3.84	....
Seaweed	1	1.0:0	18.2	10 cords	....	[a] 18.2	[a] 10.92	....
Total	302	2.6:1	....	....	5.36	4.6	2.76	— 2.66

[a] Not included in the average yield.

Results of fertilizer tests with corn soils—Continued.

ORGANIC FERTILIZERS WITH ONE MINERAL.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Dried blood Acid phosphate	37	8.2:1	−12.4 to 35.9	216 292	6.37	10.1	6.01	− 0.31
Dried blood Boneblack	1	1.0:0	19.2	264 400	9.68	19.2	11.52	1.84
Dried blood Sulphate of potash	5	4.1:1	− 0.7 to 83.4	333 309	15.95	23.3	13.98	− 1.97
Dried blood Muriate of potash	43	1.0:1	−17.5 to 35.2	213 183	8.28	1.3	0.77	− 7.51
Dried blood Kainit	4	3.0:1	− 1.0 to 14.2	267 533	8.54	8.1	4.86	− 3.68
Dried blood Lime	4	0.3:1	−22.0 to 9.1	800 2,000	22.00	−20.4	−12.24	−34.24
Tankage Cotton hulls	1	0:1	−2.8	300 100	4.12	− 2.8	− 1.68	− 5.80
Tankage Muriate of potash	10	5.0:1	− 5.7 to 31.3	410 100	7.53	8.0	4.80	− 4.50
Tankage Cotton-seed-hull ashes	1	1.0:0	5.8	300 280	8.66	5.8	3.48	− 5.18
Ground bone Boneblack	1	1.0:0	15.4	400 320	8.72	15.4	9.24	0.52
Ground bone Sulphate of potash	1	1.0:0	7.2	400 160	10.00	7.2	4.32	− 5.68
Ground bone Muriate of potash	2	2.0:1	8.5 to 11.2	500 160	10.02	9.8	5.88	− 4.14
Ground bone Kainit	2	2.0:0	19.7 to 22.3	350 600	8.15	21.0	12.60	4.45
Ground bone Wood ashes	5	0.25:1	− 5.8 to 9.6	500	6.50	− 1.2	− 0.72	− 5.78
Ground bone Lime	5	0.7:1	−31.4 to 93.0	200 2,000	8.60	14.9	8.94	− 0.34
Ground bone Seaweed	2	2.0:1	23.2 to 32.2	400 8 cords	5.20	27.7	16.62	11.42
Boneblack Nitrate of soda	2	2.0:1	7.3 to 33.8	350 150	7.60	20.5	12.36	4.76
Boneblack Muriate of potash	1	1.0:0	6.2	350 150	7.15	6.2	3.72	− 3.43
Fish scrap Sulphate of potash	4	4.0:0	11.4 to 17.6	80 160	6.40	14.2	8.52	2.12
Fish scrap Muriate of potash	7	2.5:1	− 3.2 to 16.7	264 177	9.18	7.3	4.38	− 4.80
Fish scrap Kainit	4	4.0:0	1.4 to 22.9	80 160	2.56	8.2	4.92	2.36
Cotton seed Acid phosphate	4	3.0:1	− 0.2 to 2.0	412 220	4.84	1.0	0.60	− 4.24
Cotton-seed meal Nitrate of soda	2	2.0:0	4.0 to 6.0	125 59	3.05	5.0	3.00	− 0.05
Cotton-seed meal Acid phosphate	112	7.6:1	− 8.8 to 56.0	203 204	4.00	8.2	4.92	0.92
Cotton-seed meal Rock phosphate	4	4.0:0	8.5 to 18.5	150 200	2.77	12.2	7.32	4.55
Cotton-seed meal Floats	3	3.0:0	4.2 to 12.6	233 233	3.85	7.3	4.38	0.53
Cotton-seed meal Sulphate of potash	2	2.0:0	9.8 to 24.0	240 221	9.63	16.9	10.14	0.51
Cotton-seed meal Muriate of potash	15	15.0:0	1.2 to 17.8	308 83	5.67	6.8	4.08	− 1.59
Cotton-seed meal Kainit	75	4.0:1	− 8.0 to 20.5	243 222	4.39	5.6	3.36	− 1.03
Cotton-seed meal Cotton-seed-hull ashes	2	2.0:0	0.8 to 17.3	405 390	11.69	9.0	5.40	− 6.29

Results of fertilizer tests with corn soils—Continued.

ORGANIC FERTILIZERS WITH ONE MINERAL—Continued.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Cotton-seed meal Cotton-seed hulls	2	2.0:0	0.7 to 4.0	150 1,660	5.61	2.3	1.38	− 4.23
Wheat bran Muriate of potash	1	1.0:0	4.7	500 80	1.76	4.7	2.82	1.06
Total	364	4.1:1			5.76	7.2	4.32	− 1.44

ORGANIC FERTILIZERS WITH TWO OR MORE MINERALS.

Dried blood Boneblack Muriate of potash	1	1.0:0	12.9	264 400 200	14.80	12.9	7.74	− 7.06
Dried blood Ground bone Muriate of potash	43	7.6:1	−11.5 to 117.2	352 232 194	14.32	19.0	11.40	− 2.92
Dried blood Sulphate of ammonia Sulphate of potash	5	5.0:0	38.0 to 54.0	100 60 160	8.66	48.5	29.10	20.44
Dried blood Acid phosphate Sulphate of potash	5	4.0:1	− 0.8 to 41.5	243 506 145	12.77	15.6	9.36	− 3.41
Dried blood Acid phosphate Potash-magnesium sulphate	1	1.0:0	25.6	430 500 485	12.10	25.6	15.36	3.26
Dried blood Acid phosphate Muriate of potash	298	10.9:1	− 9.3 to 44.5	400 312 164	13.79	13.8	8.28	− 5.51
Dried blood Acid phosphate Kainit	10	9.0:1	− 3.1 to 35.8	233 280 247	8.10	11.2	6.72	− 1.38
Dried blood Ground bone Lime	3	0.5:1	−22.0 to 13.5	800 200 2,000	24.60	− 5.1	− 3.06	−27.66
Dried blood Muriate of potash Lime	7	6.0:1	−11.3 to 117.3	800 200 2,000	26.40	56.8	34.08	7.68
Tankage Acid phosphate Sulphate of potash	8	3.0:1	− 7.4 to 14.3	87 190 75	4.72	5.7	3.42	− 1.30
Tankage Acid phosphate Muriate of potash	13	12.0:1	− 2.1 to 27.5	108 100 10	2.32	9.5	5.70	3.38
Tankage Cotton-seed-hull ashes Gypsum	1	1.0:0	4.2	300 280 140	9.22	4.2	2.52	− 6.70
Ground bone Nitrate of soda Muriate of potash	14	6.0:1	− 8.4 to 35.8	171 148 117	8.51	8.8	5.28	− 3.23
Ground bone Sulphate of ammonia Muriate of potash	3	2.0:1	− 1.0 to 18.6	173 155 133	9.99	7.7	4.62	− 5.37
Ground bone Muriate of potash Lime	5	1.5:1	−19.7 to 116.5	200 200 2,000	13.00	28.4	17.04	4.04
Ground bone Sulphate of potash Gypsum	1	1.0:0	0.9	200 100 100	6.00	0.9	0.54	− 5.46
Ground bone Muriate of potash Gypsum	1	1.0:0	10.0	200 100 100	5.20	10.0	6.00	0.80
Ground bone Gypsum Soil	4	4.0:0	5.0 to 25.6	200 200 200	4.20	12.2	7.32	3.12

Results of fertilizer tests with corn soils—Continued.

ORGANIC FERTILIZERS WITH TWO OR MORE MINERALS—Continued.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Boneblack Nitrate of soda Muriate of potash	2	2.0:0	2.4 to 6.4	295 155 155	10.53	4.4	2.64	−7.89
Boneblack Sulphate of ammonia Muriate of potash	3	3.0:0	5.5 to 14.5	256 258 116	13.37	9.1	5.46	−7.91
Fish scrap Acid phosphate Kainit	5	5.0:0	10.7 to 15.6	403 112 56	9.18	12.8	7.60	−1.50
Guano Sulphate of ammonia Muriate of potash	4	4.0:0	15.2 to 35.5	725 150 100	24.97	25.2	15.12	−9.85
Azotine Nitrate of soda Sulphate of ammonia	4	3.0:1	− 2.0 to 6.0	80 40 40	2.24	2.5	1.50	−0.74
Ammonite Acid phosphate Muriate of potash	2	2.0:0	19.8 to 24.9	190 480 160	6.88	24.6	14.76	7.88
Cotton seed Acid phosphate Muriate of potash	7	7.0:0	1.0 to 14.3	552 242 55	7.33	9.8	5.88	−1.45
Cotton seed Acid phosphate Kainit	14	14.0:0	0.2 to 11.2	1,038 112 56	9.42	6.2	3.72	−5.70
Cotton-seed meal Nitrate of soda Acid phosphate	5	5.0:0	1.8 to 10.4	181 50 293	5.55	6.1	3.66	−1.89
Cotton-seed meal Acid phosphate Nitrate of potash	9	8.0:1	0 to 12.0	134 280 76	5.54	6.5	3.90	−1.64
Cotton-seed meal Acid phosphate Sulphate of potash	22	21.0:1	0 to 15.0	271 229 55	6.65	7.2	4.32	−2.33
Cotton-seed meal Acid phosphate Muriate of potash	59	13.9:1	− 2.9 to 16.1	315 232 70	7.10	5.8	3.48	−3.62
Cotton-seed meal Acid phosphate Kainit	145	6.6:1	−11.7 to 25.4	198 212 140	4.81	7.0	4.20	−0.61
Cotton-seed meal Acid phosphate Cotton-seed-hull ashes	7	7.0:0	0.6 to 8.5	314 173 125	6.01	5.8	3.48	−2.53
Cotton-seed meal Acid phosphate Wood ashes	1	1.0:0	7.2	400 300 2,000	12.10	7.2	4.32	−7.78
Cotton-seed meal Acid phosphate Oyster shells	1	0:1	− 3.4	132 121 100	2.49	− 3.4	−2.04	−4.53
Cotton-seed meal Rock phosphate Kainit	2	2.0:0	0.9 to 1.1	200 200 200	4.60	2.0	1.20	−3.40
Cotton-seed meal Floats Muriate of potash	3	3.0:0	3.6 to 6.8	310 280 90	6.97	5.1	3.06	−3.91
Cotton-seed meal Floats Kainit	7	7.0:0	8.6 to 13.8	317 173 100	5.27	11.3	6.78	1.51
Cotton-seed meal Basic slag Kainit	4	4.0:0	4.2 to 15.0	336 168 84	5.75	9.4	5.64	−0.11
Cotton-seed meal Muriate of potash Gypsum	3	2.0:1	− 1.7 to 3.5	280 84 187	6.09	1.8	1.08	−5.01
Cotton-seed meal Kainit Gypsum	8	1.7:1	− 7.5 to 5.0	255 347 210	6.11	0	0	−6.12

Results of fertilizer tests with corn soils—Continued.

ORGANIC FERTILIZERS WITH TWO OR MORE MINERALS—Continued.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Cotton-seed meal	1	1.0:0	1.2	310	9.20	1.2	0.72	−8.48
Cotton-seed hull ashes				280				
Gypsum				140				
Cotton-seed meal	9	3.5:1	−10.2 to 11.8	269	11.55	2.9	1.74	−9.81
Ground bone				385				
Muriate of potash				144				
Cotton-seed meal	12	12.0:0	2.9 to 17.8	300	8.64	11.7	7.02	−1.62
Ground bone				277				
Kainit				215				
Cotton-seed meal	1	1.0:0	6.9	200	5.10	6.9	4.14	−0.96
Manure				2,000				
Acid phosphate				300				
Linseed meal	9	8.0:1	−4.9 to 13.4	500	11.25	4.8	2.88	−8.37
Acid phosphate				30				
Muriate of potash				70				
Wheat bran	7	7.0:0	1.6 to 7.8	500	3.43	5.2	3.12	−0.31
Nitrate of soda				80				
Muriate of potash				65				
Peat	1	0:1	−6.7	20,000	6.30	−6.7	−4.02	−10.32
Rock phosphate				600				
Sulphate of potash				120				
Seaweed	1	1.0:0	22.8	10 cds.	8.48	22.8	13.68	5.20
Sulphate of ammonia				160				
Muriate of potash				160				
Dried blood	6	6.0:0	0.8 to 131.7	800	29.00	53.5	32.10	3.10
Ground bone				200				
Muriate of potash				200				
Lime				2,000				
Dried blood	30	30.0:0	3.6 to 35.9	108	9.19	13.9	8.38	−0.81
Nitrate of soda				74				
Acid phosphate				398				
Muriate of potash				109				
Dried blood	24	24.0:0	6.9 to 38.3	100	9.51	21.3	12.78	3.27
Nitrate of soda				75				
Basic slag				550				
Muriate of potash				100				
Dried blood	9	9.0:0	11.5 to 25.6	513	23.87	17.6	10.56	−13.31
Acid phosphate				600				
Muriate of potash				200				
Lime				1,667				
Tankage	1	1.0:0	6.0	75	3.49	6.0	3.60	0.11
Nitrate of soda				15				
Acid phosphate				165				
Muriate of potash				45				
Boneblack	1	1.0:0	34.2	30	5.52	34.2	20.52	15.00
Sulphate of ammonia				80				
Acid phosphate				340				
Muriate of potash				15				
Ground bone	1	1.0:0	5.5	200	12.20	5.5	3.30	−8.90
Sulphate of ammonia				200				
Sulphate of potash				100				
Gypsum				100				
Ground bone	1	1.0:0	1.9	200	4.12	1.9	1.14	−2.98
Wood ashes				368				
Salt				100				
Gypsum				50				
Fish scrap	1	1.0:0	8.1	75	4.73	8.1	4.86	0.13
Nitrate of soda				50				
Acid phosphate				125				
Muriate of potash				50				
Fish scrap	3	0.5:1	−3.6 to 18.1	23	1.72	3.9	2.34	0.62
Floats				280				
Sylvanite				19				
Muriate of potash				6				
Ammonite	4	4.0:0	8.2 to 36.0	90	9.97	18.8	11.28	1.31
Nitrate of soda				107				
Acid phosphate				475				
Muriate of potash				180				

Results of fertilizer tests with corn soils—Continued.

ORGANIC FERTILIZERS WITH TWO OR MORE MINERALS—Continued.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Azotine Nitrate of soda Sulphate of ammonia Muriate of potash	9	8.0:1	— 8.0 to 12.0	80 40 40 160	5.76	4.7	2.82	— 2.94
Azotine Nitrate of soda Sulphate of ammonia Acid phosphate	9	9.0:0	6.0 to 30.0	80 40 40 400	5.04	11.1	6.66	1.62
Azotine Nitrate of soda Sulphate of ammonia Acid phosphate Muriate of potash	10	9.0:1	— 6.0 to 18.0	80 40 40 400 160	8.56	8.4	5.04	— 3.52
Cotton seed Nitrate of soda Acid phosphate Muriate of potash	10	10.0:0	2.2 to 5.8	450 17 270 88	7.85	4.0.	2.40	— 5.45
Cotton-seed meal Cotton-seed hulls Acid phosphate Muriate of potash	4	4.0:0	12.3 to 13.6	143 180 286 37	5.01	13.1	7.86	2.85
Cotton-seed meal Nitrate of soda Acid phosphate Sulphate of potash	16	15.0:1	— 0.3 to 3.7	158 23 171 25	4.50	1.7	1.02	— 3.48
Cotton-seed meal Nitrate of soda Acid phosphate Muriate of potash	116	10.6:1	— 3.2 to 18.8	203 24 216 16	5.00	4.5	2.70	— 2.30
Cotton-seed meal Acid phosphate Kainit Oyster shells	1	0:1	— 3.0	132 121 56 100	2.83	—3.0	—1.80	— 4.63
Total	1,037	10.0:1			9.40	10.8	6.48	— 2.92

MANURE AND COMPOST.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Used.	Cost.	Crop increase per acre (Bushels).	Crop increase per acre (Dollars).	Average gain per acre.
Manure	351	11.5:1	— 6.8 to 144.0	22,015	5.50	13.7	8.22	2.72
Cow manure	8	7.0:1	—19.2 to 85.8	48,550	12.14	24.1	14.46	2.32
Hog manure	7	6.0:1	— 4.6 to 94.7	63.991	16.00	32.3	19.38	3.38
Hen manure	4	0.3:1	— 7.6 to 15.7	6,000	45.00	1.2	.72	—44.28
Manure Guano	1	1.0:0	17.6	32,000 200	13.00	17.6	10.56	2.44
Manure Acid phosphate	29	29.0:0	1.0 to 67.4	13,828 298	5.54	24.5	14.70	9.16
Manure Lime	25	24.0:1	— 4.4 to 44.4	13,168 3,636	14.20	14.7	8.82	— 5.38
Manure Floats	22	22.0:0	13.0 to 53.6	16,000 320	5.28	26.7	16.02	10.74
Manure Kainit	22	22.0:0	3.3 to 54.0	16,000 320	5.92	22.8	13.68	7.76
Manure Gypsum	23	23.0:0	1.6 to 52.5	15,348 315	5.10	23.9	14.34	9.24
Manure Sand	2	2.0:0	7.3 to 13.9	32,000 1,600	8.00	10.6	6.36	—1.64
Manure Sulphate of ammonia Muriate of potash	1	1.0:0	30.3	5,667 160 160	9.90	30.3	18.18	8.28
Manure Acid phosphate Muriate of potash	3	2.0:1	— 1.0 to 16.5	7,000 320 160	7.51	8.2	4.92	—2.59

Results of fertilizer tests with corn soils—Continued.

MANURE AND COMPOST—Continued.

Kind of fertilizers used.	Number of experiments.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Crop increase per acre.		Average gain per acre.
				Used.	Cost.			
		Ratio.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Dollars.*	*Dollars.*
Manure	2	2.0:0	40.4 to 43.7	32,000	11.40	42.0	25.20	13.80
Sulphate of potash				100				
Gypsum				100				
Manure	3	3.0:0	6.3 to 7.5	4,000	6.36	6.8	4.08	−2.28
Nitrate of soda				130				
Acid phosphate				50				
Muriate of potash				65				
Compost	28	8.3:1	−10.0 to 28.8	9,831	2.46	9.3	5.58	3.12
Total	531	12.9:1	....	....	6.35	15.8	9.48	3.13

COMMERCIAL FERTILIZERS.

Commercial fertilizers[a]	269	3.8:1	−22.5 to 100.0	379	3.79	8.3	4.98	1.19

[a] Composition not stated.

The salient facts set forth in the preceding table are recapitulated below:

Summary of results given in preceding table.

Kind of fertilizer used.	Number of experiments.	Increase.	No increase.	Ratio.	Mean increase in bushels.
Minerals alone	1,622	1,058	564	1.9:1	3.7
Minerals in combinations of two	1,036	886	150	5.9:1	11.0
Minerals in combinations of three or more	1,233	1,139	94	12.1:1	14.5
Organic fertilizers alone	302	218	84	2.6:1	4.6
Organic fertilizers in combination with one mineral	364	292	72	4.1:1	7.2
Organic fertilizers in combination with two or more minerals	1,037	945	92	10.3:1	10.8
Manure alone and with minerals and compost	531	493	38	12.9:1	15.8
Commercial fertilizers	269	213	56	3.8:1	8.3
Total	6,394	5,244	1,150	4.6:1	9.2

From the summary it appears that with two or three substances combined the chances for a gain in yield are increased. For minerals the ratios of the number of cases of reported increase to no increase are 1.9, 5.9, and 12.1 to 1, accordingly as one, two, or three or more substances are used, while the corresponding increases in crop are 3.7, 11.0, and 14.5 bushels per acre, respectively.

With the organic fertilizers, such as dried blood, fish scrap, cotton seed, and cotton-seed meal, the chances to obtain an increase are greater when one or two minerals are added, as shown by the ratios 2.6, 4.1, and 10.3 to 1 and by the increases of 4.6, 7.2, and 10.8 bushels per acre.

EFFECTIVENESS OF SINGLE SUBSTANCES AND MIXTURES.

In the following table are given the average increases in crop attributable to all mixtures, with which more than 10 or 15 tests have been made. These increases are compared with the increases attributable to the separate ingredients. It must be understood that these tests were not made on a single farm but cover the entire field of experimentation.

Increase in yield of shelled corn per acre due to single fertilizers, compared with increase due to mixtures of these fertilizers.

Fertilizers.	Number of experiments.	Increase per acre.
	Acres.	*Bushels.*
Nitrate of soda	249	3.8
Acid phosphate	405	3.4
		7.2
Mixture	196	10.4
Nitrate of soda	249	3.8
Muriate of potash	289	6.3
		10.1
Mixture	194	11.9
Nitrate of soda	249	3.8
Kainit	84	4.9
		8.7
Mixture	10	6.5
Sulphate of ammonia	52	0.9
Acid phosphate	405	3.4
		4.3
Mixture	20	7.6
Sulphate of ammonia	52	0.9
Muriate of potash	289	6.3
		7.2
Mixture	18	16.2
Acid phosphate	405	3.4
Muriate of potash	289	6.3
		9.7
Mixture	455	12.1
Acid phosphate	405	3.4
Kainit	84	4.9
		8.3
Mixture	82	3.2
Nitrate of soda	249	3.8
Acid phosphate	405	3.4
Muriate of potash	289	6.3
		13.5
Mixture	677	13.1
Nitrate of soda	249	3.8
Acid phosphate	405	3.4
Kainit	84	4.9
		12.1
Mixture	36	14.9
Nitrate of soda	249	3.8
Rock phosphate	54	1.7
Muriate of potash	289	6.3
		11.8
Mixture	14	12.0
Nitrate of soda	249	3.8
Basic slag	23	− 0.5
Muriate of potash	289	6.3
		9.6
Mixture	32	7.9
Sulphate of ammonia	52	0.9
Acid phosphate	405	3.4
Muriate of potash	289	6.3
		10.6
Mixture	389	17.5
Dried blood	45	2.0
Acid phosphate	405	3.4
		5.4
Mixture	37	10.1
Dried blood	45	2.0
Muriate of potash	289	6.3
		8.4
Mixture	43	1.3
Cotton-seed meal	83	6.0
Acid phosphate	405	3.4
		9.4
Mixture	112	8.2
Cotton-seed meal	83	6.0
Muriate of potash	289	6.3
		12.3
Mixture	15	6.8
Cotton-seed meal	83	6.0
Kainit	84	4.9
		10.9
Mixture	75	5.6
Dried blood	45	2.0
Ground bone	70	3.0
Muriate of potash	289	6.3
		11.4
Mixture	43	19.0
Dried blood	45	2.0
Acid phosphate	405	3.4
Muriate of potash	289	6.3
		11.7
Mixture	298	13.8
Cotton-seed meal	83	6.0
Acid phosphate	405	3.4
Sulphate of potash	23	6.3
		15.7
Mixture	22	7.2

Increase in yield of shelled corn per acre due to single fertilizers, compared with increase due to mixtures of these fertilizers—Continued.

Fertilizers.	Number of experiments.	Increase per acre.
	Acres.	*Bushels.*
Cotton-seed meal	83	6.0
Acid phosphate	405	3.4
Muriate of potash	289	6.3
		15.7
Mixture	59	5.8
Cotton-seed meal	83	6.0
Acid phosphate	405	3.4
Kainit	84	4.9
		14.3
Mixture	145	7.0
Dried blood	45	2.0
Nitrate of soda	249	3.8
Acid phosphate	405	3.4
Muriate of potash	289	6.3
		15.5
Mixture	30	13.9
Dried blood	45	2.0
Nitrate of soda	249	3.8
Basic slag	23	− 0.5
Muriate of potash	289	6.3
		11.6
Mixture	24	21.3
Cotton-seed meal	83	6.0
Nitrate of soda	249	3.8
Acid phosphate	405	3.4
Muriate of potash	289	6.3
		19.5
Mixture	116	4.5

The increase in yield attributable to the mixtures is in all cases greater than the increase attributable to any individual constituent of the mixture used separately, but is sometimes less and sometimes greater than the sum of the effects of the individual constituents when these have been used alone, so that no exact relation is shown.

EFFECTIVENESS OF DIFFERENT AMOUNTS OF FERTILIZERS.

The following table contains all available data bearing on the relative effectiveness of different amounts of fertilizers applied to the soil:

Increase in yield of shelled corn attributable to different amounts of fertilizers.

Name of fertilizer.	Quantity per acre.	Number of experiments.	Range of crop increases.	Average increase per acre.
	Pounds.		*Bushels.*	*Bushels.*
Nitrate of soda	Below 50	1	5.0	5.0
	50 to 99	6	− 2.4 to 8.0	4.4
	100 to 149	20	−20.3 to 13.5	3.6
	150 to 199	169	−11.5 to 22.1	3.6
	200 to 249	16	− 7.6 to 21.4	4.9
	250 to 299	6	− 9.7 to 28.0	5.2
	300 to 349	11	− 8.5 to 15.8	4.1
	350 to 399	2	0.3 to 2.6	1.4
	400 to 500	14	− 7.8 to 9.1	2.0
	500+	4	0.3 to 21.4	8.4
Sulphate of ammonia	50 to 99	3	5.2 to 11.2	7.7
	100 to 149	17	− 8.0 to 6.9	− 1.4
	150 to 199	1	15.8	15.8
	200 to 249	11	−10.8 to 5.6	0
	250 to 299	8	− 4.0 to 43.1	8.6
	300 to 349	1	0.6	0.6
	350 to 399	....	....	....
	400 to 500	5	−16.6 to −0.3	− 5.5
	500+	6	− 7.9 to 2.3	0.9

Increase in yield of shelled corn attributable to different amounts of fertilizers—Continued.

Name of fertilizer.	Quantity per acre.	Number of experiments.	Range of crop increases.	Average increase per acre.
	Pounds.		*Bushels.*	*Bushels.*
Acid phosphate	50 to 99	13	− 2.2 to 19.8	4.0
	100 to 149	18	− 5.0 to 13.7	2.7
	150 to 199	3	4.1 to 17.8	8.8
	200 to 249	25	− 7.8 to 15.3	3.7
	250 to 299	19	− 7.0 to 14.5	6.3
	300 to 349	151	−22.0 to 30.6	2.2
	350 to 399	51	− 6.5 to 31.0	6.1
	400 to 500	80	−26.6 to 30.1	2.9
	500+	46	−19.9 to 46.9	3.5
Muriate of potash	50 to 99	36	− 9.0 to 27.2	3.7
	100 to 149	37	−11.7 to 42.5	4.0
	150 to 199	152	− 9.6 to 82.4	7.2
	200 to 249	37	−19.0 to 22.7	2.1
	250 to 299	2	7.7 to 10.4	9.0
	300 to 349	10	−11.9 to 11.6	1.4
	350 to 399	...	...	...
	400 to 500	7	−10.2 to 36.9	20.3
	500+	8	− 7.4 to 74.7	23.8
Kainit	100 to 149	9	− 5.6 to 21.2	1.8
	150 to 199	7	− 2.8 to 6.6	2.3
	200 to 249	10	− 5.0 to 20.0	2.9
	250 to 299	2	− 7.3 to 10.1	1.4
	300 to 349	21	− 4.0 to 15.8	2.7
	350 to 399	...	...	...
	400 to 500	19	− 5.0 to 14.6	4.8
	500+	16	− 8.1 to 40.4	12.9
Dried blood	50 to 99	2	1.5 to 2.0	1.7
	100 to 149	6	− 4.2 to 7.7	1.7
	150 to 199	10	− 8.2 to 5.0	0.4
	200 to 249	24	−14.2 to 18.2	1.2
	250+	2	2.4 to 20.9	13.6
Ground bone	100 to 149	3	2.9 to 8.6	5.5
	150 to 199	3	− 3.0 to 19.9	10.0
	200 to 249	16	−11.6 to 14.5	1.0
	250 to 299	5	− 1.9 to 22.0	7.1
	300 to 349	5	−25.5 to 9.7	0.8
	350 to 399	...	...	...
	400 to 449	18	− 6.6 to 24.9	6.3
	450 to 499	...	...	...
	500+	20	−22.9 to 17.3	0
Cotton seed	200 to 499	7	− 5.4 to 9.9	3.4
	500 to 699	8	− 2.0 to 12.4	4.1
	700 to 999	9	0.2 to 9.2	4.1
	1,000+	12	− 6.8 to 8.9	6.1
Cotton-seed meal	Below 200	5	− 4.6 to 9.0	− 0.7
	200 to 299	50	− 6.8 to 11.0	3.5
	300 to 399	7	4.4 to 9.9	6.6
	400 to 499	24	− 8.6 to 18.2	8.1
	500+	17	2.5 to 17.4	9.7
Lime	Below 400	3	− 3.9 to 11.2	1.5
	400 to 999	10	− 9.6 to 12.5	1.3
	1,000 to 1,999	38	− 9.1 to 32.4	13.3
	2,000 to 2,999	37	−38.4 to 50.9	5.0
	3,000 to 3,999	10	− 3.0 to 21.7	11.5
	4,000 to 4,999	63	−21.8 to 19.9	− 2.1
	5,000+	6	− 2.9 to 14.9	4.4
Gypsum	50 to 99	7	− 2.9 to 11.0	4.1
	100 to 149	...	...	...
	150 to 199	12	− 6.0 to 4.0	− 0.8
	200 to 249	15	− 2.6 to 13.7	3.5
	250 to 299	2	− 4.9 to 8.6	1.9
	300 to 349	65	−18.2 to 21.0	− 0.2
	350 to 399	3	1.7 to 8.9	5.8
	400 to 500	61	−20.4 to 17.7	0.1
	500+	8	−38.3 to 7.5	− 1.7
Manure	Below 5,000	19	− 6.1 to 29.0	6.3
	5,000 to 9,999	25	− 1.6 to 59.0	13.3
	10,000 to 14,999	42	− 6.8 to 34.4	12.1
	15,000 to 19,999	104	− 6.2 to 52.6	11.9
	20,000 to 29,999	58	− 2.5 to 88.6	15.7
	30,000 to 39,999	38	−10.3 to 144.0	21.4
	40,000 to 49,999	52	− 5.5 to 45.0	14.6
	50,000+	12	− 2.0 to 19.7	8.6

Increase in yield of shelled corn attributable to different amounts of fertilizers—Continued.

Name of fertilizer.	Quantity per acre.	Number of experiments.	Range of crop Increases.	Average increase per acre.
	Pounds.		*Bushels.*	*Bushels.*
Compost	Below 10,000	11	2.2 to 13.4	6.8
	10,000 to 20,000	14	−10.0 to 28.8	11.3
	20,000+	3	1.1 to 16.0	8.6
Commercial fertilizers	Below 200	7	− 4.8 to 96.0	14.5
	200 to 299	142	−21.0 to 31.3	6.6
	300 to 399	36	−22.5 to 24.4	5.4
	400 to 499	26	− 8.0 to 48.0	8.7
	500 to 599	20	− 5.3 to 100.0	16.6
	600 to 699	17	− 0.8 to 25.3	10.6
	700+	21	1.2 to 63.2	12.4

Although the results vary considerably, there is no indication of any significant increase or decrease of effect attributable to varying the amounts of any single fertilizer within the limits of the experiments.

EFFECTIVENESS OF FERTILIZERS ON SOILS OF DIFFERENT PRODUCTIVITY.

In the following table are arranged the average results from all single fertilizers and mixtures with which at least a total of thirty or forty tests have been recorded, arranged according to the yield of the unfertilized "check" plats to see if the effectiveness of the fertilizers are influenced in any way by the natural productivity of the soil.

Increase of yields with different fertilizers arranged according to the yields on the unfertilized plats.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	Bushels.		*Bushels.*	*Bushels.*
Nitrate of soda	1.0 to 4.9	13	− 8.0 to 9.1	2.9
	5.0 to 9.9	19	− 7.8 to 15.8	3.2
	10.0 to 14.9	30	− 9.0 to 18.2	2.9
	15.0 to 19.9	30	−10.7 to 21.4	6.3
	20.0 to 29.9	51	−11.2 to 16.3	4.8
	30.0 to 39.9	40	−20.3 to 28.0	1.3
	40.0 to 49.9	23	−10.1 to 21.4	6.2
	50.0 to 59.9	27	− 9.7 to 22.1	2.2
	60.0 to 69.9	11	− 5.1 to 17.6	5.2
	70.0+	8	− 2.5 to 13.5	0.6
Sulphate of ammonia	5.0 to 9.9	2	0.3 to 6.7	3.5
	10.0 to 14.9	4	− 4.8 to 11.2	2.7
	15.0 to 19.9	1	6.9	6.9
	20.0 to 29.9	7	− 7.7 to 4.2	1.9
	30.0 to 39.9	10	−10.8 to 16.9	− 1.1
	40.0 to 49.9	4	− 7.9 to 13.4	1.6
	50.0 to 59.9	12	−16.6 to 5.6	− 1.6
	60.0 to 69.9	4	2.3 to 43.1	18.4
	70.0+	8	− 6.8 to	− 3.1
Acid phosphate	1.0 to 4.9	19	− 1.1 to 23.1	8.8
	5.0 to 9.9	30	− 3.5 to 20.6	4.0
	10.0 to 14.9	43	− 5.9 to 22.7	4.5
	15.0 to 19.9	37	−12.0 to 29.0	6.6
	20.0 to 29.9	75	−17.6 to 30.6	4.6
	30.0 to 39.9	68	−19.9 to 46.9	4.2

Increase of yields with different fertilizers arranged according to the yields on the unfertilized plats—Continued.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	Bushels.		*Bushels.*	*Bushels.*
Acid phosphate	40.0 to 49.9	51	− 8.2 to 30.3	4.9
	50.0 to 59.9	65	−26.6 to 163.6	3.7
	60.0 to 69.9	21	−17.8 to 25.6	0.7
	70.0	25	−22.0 to 30.0	− 1.6
Rock phosphate	1.0 to 4.9	3	4.3 to 7.3	5.4
	5.0 to 9.9	....	....	....
	10.0 to 14.9	1	....	38.7
	15.0 to 19.9	2	7.3 to 12.1	9.7
	20.0 to 29.9	....	....	....
	30.0 to 39.9	23	−26.0 to 13.4	− 0.1
	40.0 to 49.9	20	− 7.0 to 6.8	0.3
	50.0 to 59.9	13	− 4.5 to 58.4	8.8
	60.0 to 69.9	3	1.1 to 9.1	4.4
	70.0	2	−12.0 to 20.2	4.1
Muriate of potash	1.0 to 4.9	14	− 0.9 to 45.1	10.9
	5.0 to 9.9	19	− 6.0 to 38.0	5.0
	10.0 to 14.9	30	− 7.7 to 82.4	8.9
	15.0 to 19.9	31	− 6.0 to 27.1	6.4
	20.0 to 29.9	60	−11.1 to 74.7	8.5
	30.0 to 39.9	48	−11.8 to 42.5	6.1
	40.0 to 49.9	32	− 7.4 to 24.6	4.4
	50.0 to 59.9	27	− 6.0 to 22.9	3.0
	60.0 to 69.9	18	−27.0 to 27.6	0.2
	70.0	12	− 0.8 to 30.0	7.9
Kainit	1.0 to 4.9	1	....	− 1.5
	5.0 to 9.9	14	− 8.2 to 18.9	2.3
	10.0 to 14.9	24	− 0.7 to 26.3	7.4
	15.0 to 19.9	14	− 5.6 to 11.6	1.1
	20.0 to 29.9	15	− 7.3 to 40.4	3.9
	30.0 to 39.9	7	− 1.0 to 21.2	12.2
	40.0 to 49.9	3	− 1.0 to 5.7	3.3
	50.0 to 59.9	4	− 1.7 to 6.3	3.0
	60.0 to 69.9	2	− 8.1 to 20.2	6.1
Lime	1.0 to 4.9	4	− 1.1 to 2.6	1.1
	5.0 to 9.9	10	− 4.8 to 14.7	4.2
	10.0 to 14.9	4	− 6.0 to 14.1	1.2
	15.0 to 19.9	11	− 8.2 to 13.5	6.6
	20.0 to 29.9	47	−18.5 to 22.0	5.9
	30.0 to 39.9	28	−11.0 to 20.1	4.9
	40.0 to 49.9	27	−20.4 to 21.7	− 3.1
	50.0 to 59.9	33	−26.6 to 18.0	− 2.4
	60.0 to 69.9	6	−15.0 to 14.3	− 1.7
	70.0	10	−38.4 to 50.4	9.2
Gypsum	1.0 to 4.9	5	0.8 to 5.1	1.9
	5.0 to 9.9	11	− 2.0 to 9.4	3.1
	10.0 to 14.9	16	− 6.0 to 17.7	2.5
	15.0 to 19.9	13	− 5.6 to 7.8	0.4
	20.0 to 29.9	40	−18.2 to 10.4	2.5
	30.0 to 39.9	27	−12.9 to 21.0	2.4
	40.0 to 49.9	25	−10.9 to 12.0	2.2
	50.0 to 59.9	22	− 8.9 to 7.8	1.4
	60.0 to 69.9	7	− 4.9 to 2.0	− 1.6
	70.0	5	−38.3 to 7.3	−11.0
Nitrate of soda and acid phosphate	1.0 to 4.9	15	2.6 to 30.1	14.8
	5.0 to 9.9	16	1.5 to 38.2	14.5
	10.0 to 14.9	21	1.3 to 31.4	9.4
	15.0 to 19.9	26	− 4.0 to 26.5	10.0
	20.0 to 29.9	39	− 3.4 to 34.3	10.5
	30.0 to 39.9	32	− 5.2 to 30.5	9.0
	40.0 to 49.9	18	0.8 to 23.2	11.2
	50.0 to 59.9	17	− 4.0 to 19.0	9.6
	60.0 to 69.9	11	− 1.5 to 21.1	7.1
	70.0+	4	− 8.5 to 17.4	3.9
Nitrate of soda and muriate of potash	1.0 to 4.9	16	− 0.9 to 56.1	15.5
	5.0 to 9.9	14	− 3.1 to 43.7	12.7
	10.0 to 14.9	19	− 8.4 to 84.0	14.6
	15.0 to 19.9	27	− 3.0 to 38.0	12.8
	20.0 to 29.9	39	− 6.2 to 40.7	10.0
	30.0 to 39.9	31	−15.2 to 74.5	9.5
	40.0 to 49.9	19	− 0.1 to 20.6	9.3
	50.0 to 59.9	12	− 1.9 to 28.4	11.2
	60.0 to 69.9	11	3.1 to 23,4	9.6
	70.0+	5	− 4.0 to 41.0	17.3

Increase of yields with different fertilizers arranged according to the yields on the unfertilized plats—Continued.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	Bushels.		*Bushels.*	*Bushels.*
Acid phosphate and muriate of potash	1.0 to 4.9	32	1.4 to 55.3	18.0
	5.0 to 9.9	32	− 2.7 to 68.8	13.9
	10.0 to 14.9	40	−10.5 to 94.8	13.0
	15.0 to 19.9	55	− 6.2 to 44.8	11.5
	20.0 to 29.9	101	− 7.4 to 69.4	13.7
	30.0 to 39.9	74	−13.6 to 73.4	10.3
	40.0 to 49.9	44	− 2.5 to 26.2	11.9
	50.0 to 59.9	47	−13.4 to 42.4	10.6
	60.0 to 69.9	24	−14.0 to 24.6	6.0
	70.0+	11	−0.7 to 112.0	20.4
Acid phosphate and kainit	1.0 to 4.9	4	− 0.6 to 5.4	3.5
	5.0 to 9.9	13	− 3.0 to 27.8	5.7
	10.0 to 14.9	28	− 3.6 to 12.8	3.2
	15.0 to 19.9	7	−13.1 to 16.6	3.3
	20.0 to 29.9	15	− 1.4 to 17.0	4.3
	30.0 to 39.9	4	− 4.0 to 2.2	− 1.1
	40.0 to 49.9	2	4.3 to 16.1	10.2
	50.0 to 59.9	6	− 3.2 to 11.8	3.9
	60.0 to 69.9	3	− 5.3 to 4.0	− 2.1
Nitrate of soda, acid phosphate, and muriate of potash	1.0 to 4.9	31	4.4 to 68.3	28.6
	5.0 to 9.9	60	0.2 to 53.8	13.9
	10.0 to 14.9	55	− 8.4 to 84.2	15.1
	15.0 to 19.9	77	1.6 to 47.5	16.1
	20.0 to 29.9	152	− 6.1 to 56.0	13.2
	30.0 to 39.9	141	− 4.0 to 73.4	8.9
	40.0 to 49.9	64	− 6.7 to 33.0	13.6
	50.0 to 59.9	47	− 6.2 to 28.6	12.2
	60.0 to 69.9	27	− 5.3 to 26.9	9.5
	70.0+	12	− 4.5 to 68.0	18.7
Sulphate of ammonia, acid phosphate, and muriate of potash	1.0 to 4.9	21	6.7 to 52.2	27.5
	5.0 to 9.9	20	2.7 to 66.2	21.2
	10.0 to 14.9	17	3.0 to 51.7	22.6
	15.0 to 19.9	40	− 0.2 to 47.4	18.2
	20.0 to 29.9	89	− 7.5 to 81.3	20.1
	30.0 to 39.9	69	− 8.1 to 58.7	12.9
	40.0 to 49.9	40	− 3.5 to 32.5	12.5
	50.0 to 59.9	42	− 0.7 to 42.4	15.5
	60.0 to 69.9	34	−43.7 to 38.6	3.5
	70.0+	19	−15.4 to 140.0	42.3
Dried blood	1.0 to 4.9	2	2.0 to 2.1	2.1
	5.0 to 9.9	1	....	2.5
	10.0 to 14.9	3	1.2 to 7.7	4.2
	15.0 to 19.9	2	− 1.7 to 7.2	2.7
	20.0 to 29.9	8	− 8.2 to 18.2	2.9
	30.0 to 39.9	8	− 8.8 to 10.5	0.1
	40.0 to 49.9	8	− 9.6 to 20.9	0.7
	50.0 to 59.9	9	− 4.4 to 4.6	0.7
	60.0 to 69.9	2	−14.2 to 5.0	− 9.6
	70.0+	1	....	4.8
Ground bone	1.0 to 4.9	1	....	7.8
	5.0 to 9.9	5	− 1.8 to 8.6	4.2
	10.0 to 14.9	4	− 5.1 to 13.1	2.3
	15.0 to 19.9	6	− 3.0 to 19.9	10.4
	20.0 to 29.9	6	− 6.6 to 6.9	0.8
	30.0 to 39.9	21	−22.9 to 24.9	3.2
	40.0 to 49.9	13	−20.3 to 17.3	− 1.7
	50.0 to 59.9	9	−25.5 to 16.9	3.0
	60.0 to 69.9	3	−13.1 to 22.0	4.3
	70.0+	4	− 1.5 to 17.2	4.2
Cotton seed	1.0 to 4.9	3	5.4 to 6.0	5.7
	5.0 to 9.9	7	0.2 to 6.4	3.6
	10.0 to 14.9	12	− 6.8 to 9.2	4.5
	15.0 to 19.9	2	3.8 to 4.3	4.1
	20.0 to 29.9	8	− 6.1 to 9.9	3.3
	30.0 to 39.9	1	....	− 5.4
	40.0 to 49.9	3	− 2.0 to 12.4	6.0
Cotton-seed meal	1.0 to 4.9	2	− 6.3 to 3.7	− 1.3
	5.0 to 9.9	6	4.0 to 13.0	7.7
	10.0 to 14.9	19	2.6 to 17.8	9.8
	15.0 to 19.9	16	− 4.6 to 16.6	7.5
	20.0 to 29.9	20	− 3.8 to 18.2	6.0
	30.0 to 39.9	7	− 8.6 to 5.4	− 0.1
	40.0 to 49.9	11	− 6.8 to 11.0	3.9
	50.0 to 59.9	2	2.8 to 3.1	2.9

Increase of yields with different fertilizers arranged according to the yields on the unfertilized plats—Continued.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	Bushels.		*Bushels.*	*Bushels.*
Dried blood and muriate of potash	5.0 to 9.9	1	....	12.6
	10.0 to 14.9	1	....	− 0.9
	15.0 to 19.9	....	....	....
	20.0 to 29.9	8	−10.1 to 13.3	1.8
	30.0 to 39.9	8	− 5.1 to 17.9	3.8
	40.0 to 49.9	8	−15.7 to 7.3	− 4.3
	50.0 to 59.9	12	−13.9 to 28.5	1.8
	60.0 to 69.9	4	−17.5 to 35.2	8.7
	70.0+	1	....	− 0.4
Cotton-seed meal and acid phosphate	1.0 to 4.9	8	− 0.3 to 7.7	3.2
	5.0 to 9.9	11	4.0 to 26.9	11.6
	10.0 to 14.9	26	0.5 to 22.8	7.9
	15.0 to 19.9	34	− 8.8 to 22.2	8.2
	20.0 to 29.9	15	− 1.1 to 56.0	11.0
	30.0 to 39.9	12	0 to 12.7	7.5
	40.0 to 49.9	8	− 6.8 to 18.7	6.6
Cotton-seed meal and kainit	1.0 to 4.9	2	− 0.3 to −0.1	− 0.2
	5.0 to 9.9	12	5.4 to 13.0	8.6
	10.0 to 14.9	14	1.2 to 17.9	9.2
	15.0 to 19.9	11	3.4 to 12.8	6.1
	20.0 to 29.9	7	− 1.7 to 11.7	3.5
	30.0 to 39.9	11	− 4.0 to 9.7	2.7
	40.0 to 49.9	4	− 2.6 to 20.5	7.3
	50.0 to 59.9	7	− 8.0 to 1.0	− 0.9
Cotton-seed meal, acid phosphate, and muriate of potash.	5.0 to 9.9	6	4.1 to 7.0	5.1
	10.0 to 14.9	17	1.5 to 10.2	6.4
	15.0 to 19.9	4	3.1 to 14.6	9.7
	20.0 to 29.9	12	0.3 to 6.5	4.0
	30.0 to 39.9	4	11.2 to 12.8	11.8
	40.0 to 49.9	10	− 1.4 to 16.1	6.6
	50.0 to 59.9	6	− 2.9 to 6.1	0.9
Cotton-seed meal, acid phosphate, and kainit	1.0 to 4.9	4	3.1 to 5.9	4.8
	5.0 to 9.9	15	3.0 to 13.8	8.2
	10.0 to 14.9	38	1.0 to 20.4	8.4
	15.0 to 19.9	38	−11.7 to 24.4	7.8
	20.0 to 29.9	21	− 2.2 to 25.4	7.5
	30.0 to 39.9	16	− 5.0 to 15.0	5.7
	40.0 to 49.9	6	− 2.6 to 20.5	8.5
	50.0 to 59.9	7	− 8.0 to 0.7	− 4.5
Cotton-seed meal, nitrate of soda, acid phosphate, and muriate of potash	10.0 to 14.9	55	− 3.1 to 18.8	5.7
	15.0 to 19.9	8	2.9 to 6.4	4.5
	20.0 to 29.9	52	− 2.2 to 14.2	3.2
Dried blood, acid phosphate, and muriate of potash.	1.0 to 4.9	12	15.0 to 42.5	31.3
	5.0 to 9.9	20	0 to 34.2	16.2
	10.0 to 14.9	14	− 3.4 to 44.5	19.5
	15.0 to 19.9	23	− 2.8 to 39.3	15.6
	20.0 to 29.9	70	− 4.2 to 37.7	14.8
	30.0 to 39.9	54	− 9.3 to 30.1	4.5
	40.0 to 49.9	37	− 8.8 to 32.5	12.4
	50.0 to 59.9	48	− 5.7 to 38.0	9.7
	60.0 to 69.9	15	0.6 to 28.0	13.6
	70.0+	4	− 5.1 to 2.0	− 0.1
Manure	1.0 to 4.9	8	− 0.5 to 71.3	17.4
	5.0 to 9.9	13	− 8.5 to 59.0	9.8
	10.0 to 14.9	29	− 3.4 to 94.7	19.4
	15.0 to 19.9	16	− 1.6 to 18.2	8.8
	20.0 to 29.9	80	− 4.8 to 92.6	17.4
	30.0 to 39.9	64	− 4.8 to 54.1	12.9
	40.0 to 49.9	56	− 6.1 to 33.5	12.1
	50.0 to 59.9	62	−11.0 to 57.9	9.4
	60.0 to 69.9	18	− 5.5 to 45.1	11.1
	70.0	18	− 6.2 to 144.0	13.1
Commercial fertilizers	1.0 to 4.9	6	3.1 to 16.4	8.5
	5.0 to 9.9	1	....	24.2
	10.0 to 14.9	20	− 0.8 to 79.8	13.0
	15.0 to 19.9	6	− 4.3 to 25.3	10.6
	20.0 to 29.9	32	− 7.1 to 35.3	8.4
	30.0 to 39.9	82	−21.0 to 31.9	7.2
	40.0 to 49.9	67	−14.0 to 30.9	7.9
	50.0 to 59.9	57	−22.5 to 91.7	7.2
	60.0 to 69.9	20	− 6.6 to 22.6	3.4
	70.0+	14	2.0 to 100.0	24.2

The results vary considerably, but there appears to be no significant difference in the actual increases obtained from the more productive or the less productive soils.

CONCLUSIONS.

It appears from the foregoing that the experiment stations have reported the results of 6,394 tests with fertilizers on corn soils.

Duplicate check plats show such variations and the range of crop increases due to fertilizers is so wide that considerable latitude must be allowed in the interpretation of all results and quantitative comparisons should not be given too great weight.

The chances for increased yields and the actual increases are greater with two or three materials mixed than with single fertilizers.

Increasing the amount of any single fertilizer from 1 to 10 times does not appear to have any significant effect upon the increased yield obtained from the smaller amounts applied within the limits of the experiments.

From the records fertilizers appear to have yielded, on the average, about the same increase in crop on the more productive and on the less productive soils.

In the great majority of cases and in the average, the increase of product due to the use of fertilizers on corn soils does not appear to be equal to the cost of the fertilizers used to produce the increase. The average cost of the fertilizers used in all experiments was $7.06 per acre, the average increase in crop was 9.2 bushels of shelled corn, worth at 60 cents per bushel $5.52, indicating a net average loss of $1.42 per acre.

It would appear that much yet remains to be determined as to how fertilizers act before a rational and economical fertilizer practice can be worked out.

As these results have been obtained from a large number of soils, with a considerable range of productivity, over a number of years, these general conclusions, besides others of a qualitative value which can be drawn from the tables, can, in the absence of any more specific knowledge of any particular soil, be safely followed as a guide to the immediate selection of fertilizers for a corn soil.

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